

Form and function: Cell make-up

Same building blocks, but different structures?

Similar, but different

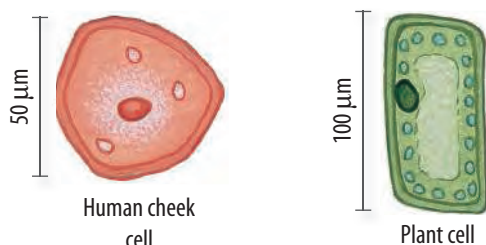
Cells are the building blocks that make up all living things. Organisms may be made up of one cell (**unicellular**) or many cells (**multicellular**). These cells contain small structures called organelles that have particular jobs within the cell and function together to keep the organism alive.

Cells can be divided on the basis of the presence and absence of particular organelles and other structural differences. Organisms can be classified by the different types of cells they are made up of.

How big is small?

The size of cells may vary between organisms and within a multicellular organism. Most cells are too small to be seen without a microscope. Cells need to be very small because they have to be able to quickly take in substances they need and remove wastes and other substances. The bigger a cell is, the longer this process would take.

Very small units of measurement are used to describe the size of cells. The most commonly used unit is the **micrometre** (μm). One micrometre equals one millionth ($1/1\,000\,000$) of a metre or one thousandth ($1/1000$) of a millimetre. Check out your ruler to get an idea of how small this is! Most cells are in the range of $1\,\mu\text{m}$ (bacteria) to $100\,\mu\text{m}$ (plant cells).



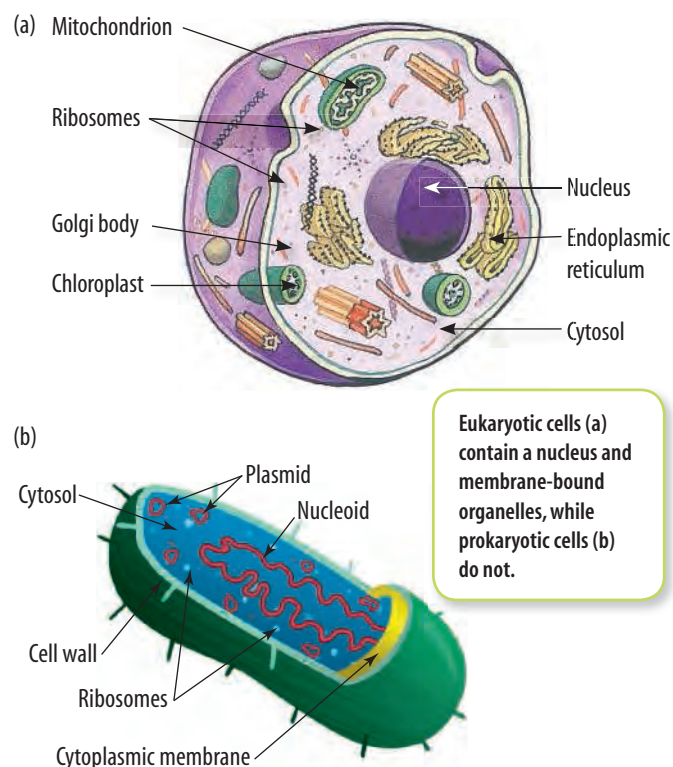
Advances in technology are creating an increased need for the use of the **nanometre** (nm) as a unit. One nanometre (nm) equals 1 billionth ($1/1\,000\,000\,000$) of a metre. Investigating the organelles within cells and the molecules they are reacting with requires this level of measurement.

Nanotechnology is a rapidly developing field that includes studying and investigating cells at this 'nanolevel'. While it requires lots of creative, exciting and futuristic 'what if' thinking, it also requires an understanding of the basics of information and ideas currently known.

Have it or not?

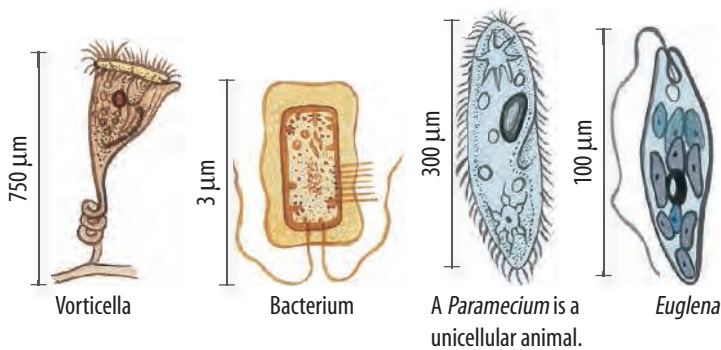
Prokaryotes such as bacteria were the first type of organism to appear on Earth. The key difference between the prokaryotes and all other kingdoms is that members of this group do not contain a nucleus or other membrane-bound organelles. The word prokaryote comes from the Greek terms *pro*, meaning 'before', and *karyon*, meaning 'nut, kernel or fruit stone', referring to the cell nucleus.

Eukaryotic organisms made up of eukaryotic cells appeared on Earth billions of years later. As *eu* is the Greek term meaning 'good', **eukaryote** can be translated as 'true nucleus'. Members of the four kingdoms Animalia, Plantae, Fungi and Protocista are eukaryotes and are made up of cells containing a nucleus and other membrane-bound organelles.



What do we share?

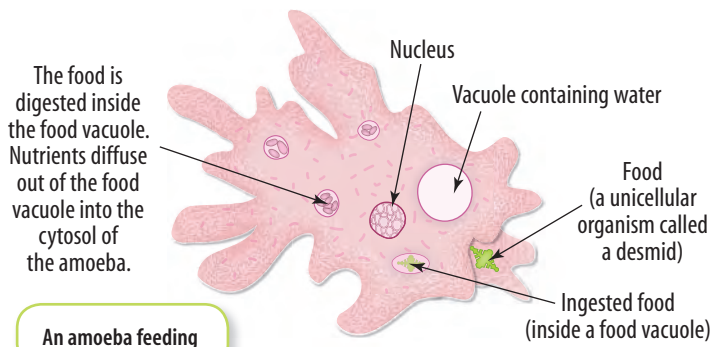
What most cells have in common is that they are made up of a **cell membrane** containing a fluid called **cytosol** and small structures called **ribosomes**. The collective term used to describe the cytosol and all the organelles suspended within it is **cytoplasm**. The hundreds of chemical reactions essential for life that occur within the cytoplasm are referred to as the cell's **metabolism**. The ribosomes are where proteins such as enzymes are made, which regulate the many chemical reactions important to life. The cell membrane regulates the movement of substances into and out of the cell. This enables the delivery of nutrients and substances essential for these reactions, and the removal of wastes.



All on my own

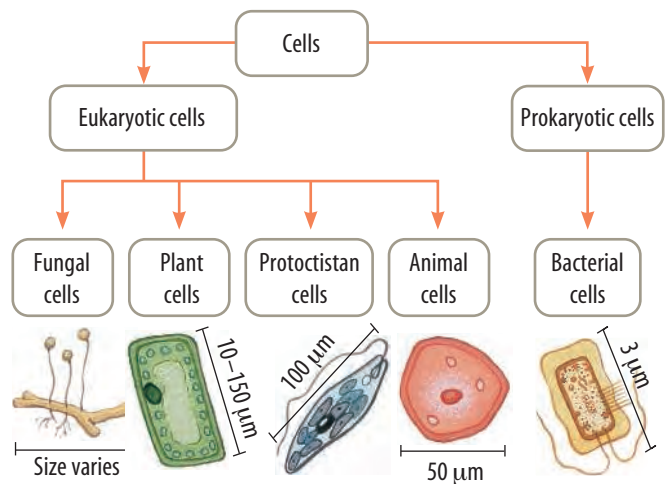
Unicellular organisms such as bacteria, *Amoeba*, *Euglena* and *Paramecium* need to carry out all the required processes themselves. They even reproduce themselves by dividing into two. This process is called **binary fission**.

To live long enough to reproduce, unicellular organisms need to be able to function on their own. They need to be able to obtain their nutrients and remove their wastes. The solution to this requirement has resulted in the wonderful diversity of unicellular organisms that are alive on our planet today or have lived in our planet's history.



Five kingdoms?

Living things can be divided into five kingdoms — **Animalia** (animals), **Plantae** (plants), **Fungi** (for example, mushrooms), **Protocista** (also called Protista) and **Prokaryotae** (also called Monera). While this system provides an opportunity to classify organisms into these groups, information from currently developing technologies means that it will not be long until a new extended classification system evolves.



A key characteristic used to classify organisms into kingdoms is the structure of their cells.



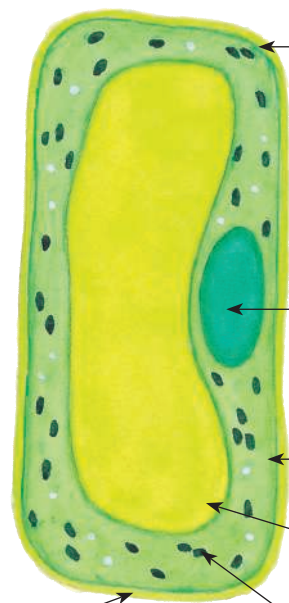
WHAT DOES IT MEAN?

The prefix *uni-* comes from the Latin term meaning 'one'. The prefix *multi-* comes from the Latin term meaning 'many'.

Specialist workers

Multicellular organisms are made up of many different types of cells that have different jobs to do. Each of these cells has a particular structure so that it is able to do the job it is specialised for. This may include the presence and number of particular organelles or additional external structures to assist with movement (such as flagella or cilia).

Plant cell



Cell wall

The tough covering around plant cells is the cell wall. It gives plant cells strength and holds them in shape. Plant cell walls are made of a substance called **cellulose**. Water and dissolved substances can pass through the cell wall. Animal cells do not have a cell wall.

Cell membrane

The thin layer that encloses the cytosol is the cell membrane. It keeps the cell together and gives it its shape. Some substances, such as water and oxygen, can pass through the cell membrane but other substances cannot. The cell membrane controls what enters and leaves the cell.

Nucleus

The nucleus is the control centre of the cell. It contains DNA in the form of chromosomes and it controls what the cell does and when.

Cytosol

The jelly-like substance inside cells is the cytosol. It contains many important substances, such as glucose, that are needed for chemical reactions that occur inside cells.

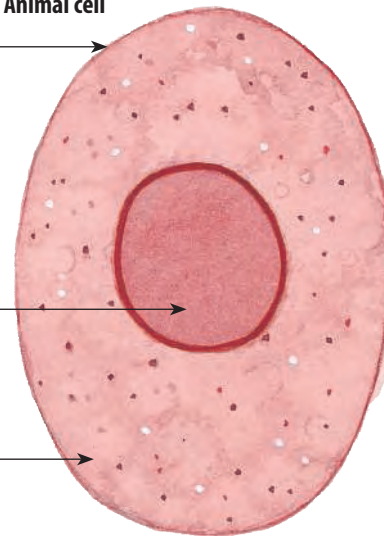
Chloroplasts

Chloroplasts are the oval-shaped organelles found only in plant cells. Chloroplasts contain a green substance called chlorophyll. Chloroplasts use energy from the sun to make food. Not all plant cells contain chloroplasts. They are found only in leaf and stem cells.

Microfactories

Mitochondria and **chloroplasts** are examples of membrane-bound organelles found in eukaryotic cells. While all eukaryotic cells contain mitochondria, because they are all involved in **cellular respiration**, only those involved in **photosynthesis** (such as those in plant leaves) contain chloroplasts. Chloroplasts contain the green pigment **chlorophyll**. This pigment is used to trap light energy so that it can be converted into chemical energy and used by the cells.

Animal cell



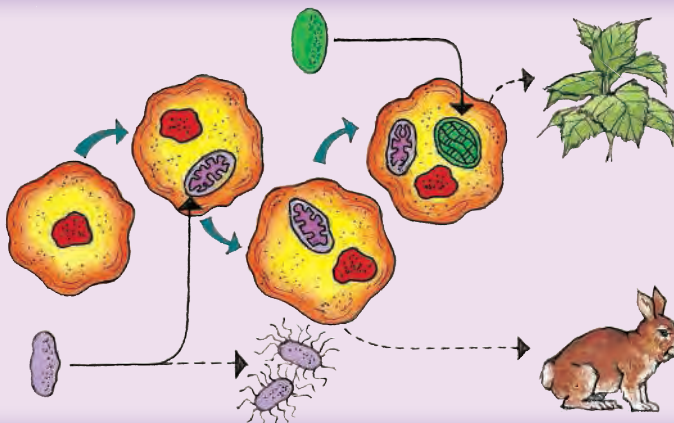
Vacuole

The vacuole is an organelle used to store water and dissolved substances. Vacuoles can look empty, like an air bubble. Plant cells usually have one large vacuole. The mixture inside a plant's vacuoles is called **cell sap**. The red, blue and violet colours that you often see in plant leaves and flowers are due to the substances stored in vacuoles. Most animal cells don't have vacuoles.

HOW ABOUT THAT!

There is a theory called the endosymbiotic theory that suggests that mitochondria and chloroplasts were once prokaryotic organisms. This theory suggests that, at some time in the past, these organisms were engulfed by another cell and over time they evolved to depend on each other.

The origin of the eukaryotic cell? Some scientists are also suggesting that our nucleus may have come from a giant viral ancestor.



Some differences in the basic cell design in the five kingdoms

Characteristic	Kingdom				
	Animalia (animals: e.g. lizards, fish, spiders, earthworms, sponges)	Fungi (e.g. yeasts, moulds, mushrooms, toadstools)	Plantae (plants: e.g. ferns, mosses, conifers, flowering plants)	Protocista (e.g. algae, protozoans)	Prokaryotae (bacteria and cyanobacteria)
Number of cells	Multicellular	Usually multicellular but some unicellular	Most multicellular	Unicellular or multicellular	Unicellular
Nucleus	Present	Present	Present	Present	Absent
Cell wall	Absent	Present	Present	Present in some	Present
Large vacuole	Absent	Absent	Present	Present in some	Absent
Chloroplasts	Absent	Absent	Present in leaf and stem cells	Present in some	Absent (but chlorophyll may be present in some)

UNDERSTANDING AND INQUIRING

REMEMBER

- 1 What do all living things have in common?
- 2 Why is the nucleus important to the cell?
- 3 State the names of the five kingdoms and use the table above to determine which kingdoms contain organisms that are eukaryotes.
- 4 What is the purpose of the cell membrane?
- 5 Identify where enzymes are made in a cell and state why they are important.
- 6 Construct a triple Venn diagram (three overlapping circles) to compare plants, animals and fungi.
- 7 Suggest why organisms are divided into five kingdoms rather than just the plant and animal kingdoms.

THINK AND REASON

Use the table above to answer the following questions.

- 8 In which kingdom(s) do the cells of an organism:
 - (a) not have a cell wall, large vacuole or chloroplasts?
 - (b) have a cell wall, large vacuole and chloroplasts?
 - (c) have a cell wall, but no large vacuole or chloroplasts?
 - (d) have a cell wall and a nucleus without a membrane around it?
- 9 List two examples of each of the five kingdoms.

Use the diagrams of cells on page 69 to complete activities 10 and 11.

- 10 Construct a table with the following headings: 'Name of organism' or 'Type of cell', and 'Cell size (μm)'.
- 11 Show the sizes of the cells on a graph, with the horizontal axis representing the type of cell and the vertical axis representing the size of cell. Sketch an outline of each cell as accurately as you can in the correct position on the graph. Which cell is the biggest and which is the smallest?

- 12 Fungi were once classified as plants. On the basis of their cells, suggest why they are no longer classified in this group.

CREATE

- 13 Make a labelled model of a cell from one of the kingdoms. Use materials available at home, such as drink bottles, egg cartons, cottonwool, wool, cotton or dry foods.

INVESTIGATE AND CREATE

- 14 What does the endosymbiotic theory suggest? Formulate questions to ask about it. Research and report on your questions.
- 15 Research and report on:
 - (a) examples of prokaryotic cells and interesting survival strategies
 - (b) mitochondrial DNA and haplogroups.
- 16 Research two of the organelles or cells listed below. Create a play and construct puppet models for your characters. Present your play to the class.
 - Nucleus
 - Mitochondrion
 - Chloroplast
 - Prokaryotic cell
 - Protocistan cell
 - Animal cell
 - Plant cell
- 17 Investigate the different types of cells and create your own picture book about them using the following steps.
 - (a) Construct a matrix table (see page 340) to show the differences between the cells of the different kingdoms.
 - (b) Construct a storyboard for a picture book about them.
 - (c) Create the picture book.